Amendments to the Claims

This listing of claims will replace all prior versions, and listings, of claims in the application.

Listing of Claims

What is claimed is:

1. (Original) An apparatus, comprising:

a receiver configured to receive multi-tone signals, wherein the receiver has a Time Domain Equalizer filter employing an algorithm to shorten a length of an incoming impulse response to equal to or less than a guard period by calculating a minimum mean square error solution in combination with measuring an inter-symbol interference of a channel.

2. (Original) The apparatus of claim 1, wherein the Time Domain Equalizer filter uses filter coefficients to make the impulse response be approximately equal in width to the guard period.

3. (Original) The apparatus of claim 1, further comprising:

a delay compensation module to determine an initial delay value to apply to the impulse response as well as supply a set of delay values for the minimum mean square error solution.

4. (Original) The apparatus of claim 3, wherein the Time Domain Equalizer filter recalculates minimum mean square error based on a set of two or more delay values.

5. (Original) The apparatus of claim 1, wherein the Time Domain Equalizer filter uses a matrix equation to determine a solution for the minimum mean-square error.

6. (Currently amended) The apparatus of claim 5, wherein the matrix equation is as follows:

$$\begin{bmatrix} r_{xx}(0) & \cdots & r_{xx}(M-1) & r_{xx}(M+1) & \cdots & r_{xx}(2M) & r_{xy}(0) & \cdots & r_{xy}(N-1) \\ \vdots & \ddots & \vdots & \vdots & \ddots & \vdots & \vdots & \ddots & \vdots \\ r_{xx}(M-1) & \cdots & r_{xx}(0) & r_{xx}(+2) & \cdots & r_{xx}(M+1) & r_{xy}(-M+1) & \cdots & r_{xy}(-M+N) \\ r_{xx}(M+1) & \cdots & r_{xx}(2) & r_{xx}(0) & \cdots & r_{xx}(M-1) & r_{xy}(-M-1) & \cdots & r_{xy}(-M+N-2) \\ \vdots & \ddots & \vdots & \vdots & \ddots & \vdots & \vdots & \ddots & \vdots \\ r_{xx}(2M) & \cdots & r_{xx}(M+1) & r_{xx}(M-1) & \cdots & r_{xx}(0) & r_{xy}(-2M) & \cdots & r_{xy}(-2M+N-1) \\ r_{xy}(0) & \cdots & r_{xy}(-M+1) & r_{xy}(-M-1) & \cdots & r_{xy}(-2M) & r_{yy}(0) & \cdots & r_{yy}(N-1) \\ \vdots & \ddots & \vdots & \vdots & \ddots & \vdots & \vdots & \ddots & \vdots \\ r_{xy}(N-1) & \cdots & r_{xy}(-M+N) & r_{xy}(-M+N-2) & \cdots & r_{xy}(-2M+N-2) & r_{yy}(N-1) & \cdots & r_{yy}(0) \end{bmatrix}$$

$$\times \begin{bmatrix} t_{-M} \\ \vdots \\ t_{-1} \\ t_{+1} \\ \vdots \\ t_{+M} \\ \\ w_0 \\ \vdots \\ w_{N-1} \end{bmatrix} = \begin{bmatrix} r_{xx}(M) \\ \vdots \\ r_{xx}(1) \\ r_{xx}(-1) \\ \vdots \\ r_{xx}(-M) \\ \\ r_{xx}(-M) \\ \vdots \\ r_{xx}(N-1-M) \end{bmatrix}$$

where r_{xx} [[,]] and r_{yy} are autocorrelation functions and r_{xy} ~~are autocorrelation and~~ is a cross-correlation function[[s]], N ~~are~~ ~~an amount~~ is a number of Time Domain Equalizing taps, and M is half a number of samples in a guard period.

7. (Original) A Digital Subscriber Line modem containing the apparatus of claim 5.

8. (Original) A method, comprising:

calculating an estimation of a first value for a center delay to shift an impulse response to a beginning of a block of time domain data in a multiple tone signal;

creating a set of values around the first value estimate to shift the impulse response that includes at least the first value for the delay and a second value for the delay;

calculating a first minimum mean square error to determine coefficients of a Time-domain Equalizer algorithm based up the first value for the delay so that the length of the overall impulse response is approximately equal to or smaller than a guard period; and

receiving a measurement of a first value of an inter-symbol interference of a channel after the first minimum mean square error is applied to the multiple tone signal.

9. (Original) The method of claim 8, further comprising:

selecting the second value for the delay, where the second value deviates a fixed amount from the first value for the delay; and

calculating a second minimum mean square error based up the second value for the delay.

10. (Original) The method of claim 9, further comprising:

receiving a measurement of a second value of an inter-symbol interference of a channel after the second minimum mean square error is applied to the multiple tone signal;

identifying the lowest value for the measured inter-symbol interference of a channel and selecting the delay value associated with that measurement; and

shortening a length of an incoming channel impulse response by applying a time-domain equalizer algorithm that uses the selected delay value to shorten the length of incoming impulse responses to approximately equal to or less than a guard period.

11. (Original) The method of claim 8, further comprising:

selecting a single tap to be set at a fixed value in a target impulse response model to prevent the target impulse response model from having a calculated zero result when modeling the target impulse response.

12. (Original) The method of claim 8, wherein the estimation of the first value for a center delay value in the set of delay values is based on locating a window of time that covers samples of the multiple tone signal with a highest power of channel impulse response.

13. (Original) A machine-readable medium storing executable instructions to a cause a device to perform operations, comprising:

calculating an estimation of a first value for a center delay to shift an impulse response to a beginning of a block of time domain data in a multiple tone signal;

creating a set of values around the first value estimate to shift the impulse response that includes at least the first value for the delay and a second value for the delay;

calculating a first minimum mean square error to determine coefficients of a Time-domain Equalizer algorithm based up the first value for the delay so that the length of the overall impulse response is approximately equal to or smaller than a guard period; and

receiving a measurement of a first value of an inter-symbol interference of a channel after the first minimum mean square error is applied to the multiple tone signal.

14. (Original) The article of manufacture of claim 13, wherein the stored instructions to cause the device to perform further operations, comprising:

selecting the second value for the delay, where the second value deviates a fixed amount from the first value for the delay; and

calculating a second minimum mean square error based ~~up~~on the second value for the delay.

15. (Original) The article of manufacture of claim 14, wherein the stored instructions to cause the device to perform further operations, comprising:

receiving a measurement of a second value of an inter-symbol interference of a channel after the second minimum mean square error is applied to the multiple tone signal;

identifying the lowest value for the measured inter-symbol interference of a channel and selecting the delay value associated with that measurement; and

shortening a length of an incoming channel impulse response by applying a time-domain equalizer algorithm that uses the selected delay value to shorten the length of incoming impulse responses to approximately equal to or less than a guard period.

16. (Original) The article of manufacture of claim 13, wherein the stored instructions to cause the device to perform further operations, comprising:

selecting a single tap to be set at a fixed value in a target impulse response model to prevent the target impulse response model from having a calculated zero result when modeling the target impulse response.

17. (Original) The article of manufacture of claim 13, wherein the estimation of the first value for a center delay value in the set of delay values is based on locating a window of time that covers samples of the multiple tone signal with a highest power of channel impulse response.

18. (Original) An apparatus, comprising:

means for calculating an estimation of a first value for a center delay to shift an impulse response to a beginning of a block of time domain data in a multiple tone signal;

means for creating a set of values around the first value estimate to shift the impulse response that includes at least the first value for the delay and a second value for the delay;

means for calculating a first minimum mean square error to determine coefficients of a Time-domain Equalizer algorithm based up the first value for the delay so that the length of the overall impulse response is approximately equal to or smaller than a guard period; and

means for receiving a measurement of a first value of an inter-symbol interference of a channel after the first minimum mean square error is applied to the multiple tone signal.

19. (Original) The apparatus of claim 18, further comprising:

means for selecting the second value for the delay, where the second value deviates a fixed amount from the first value for the delay; and

means for calculating a second minimum mean square error based up the second value for the delay.

20. (Original) The apparatus of claim 19, further comprising:

means for receiving a measurement of a second value of an inter-symbol interference of a channel after the second minimum mean square error is applied to the multiple tone signal;

means for identifying the lowest value for the measured inter-symbol interference of a channel and selecting the delay value associated with that measurement; and

means for shortening a length of an incoming channel impulse response by applying a time-domain equalizer algorithm that uses the selected delay value to shorten the length of incoming impulse responses to approximately equal to or less than a guard period.

21. (Original) The apparatus of claim 18, further comprising:

means for selecting a single tap to be set at a fixed value in a target impulse response model to prevent the target impulse response model from having a calculated zero result when modeling the target impulse response.

22. (Original) The apparatus of claim 18, wherein the estimation of the first value for the center delay is based on a best linear fit to a phase of a channel frequency response.